

WHAT IS CLAIMED IS:

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1. A protective coating for an intracorporeal substrate, comprising:
 - a. at least one inner layer formed of ceramic material; and
 - b. an outer layer formed of a water-swellable ceramic material.
 2. The protective coating of claim 1 including a plurality of inner ceramic bilayers.
 3. The protective coating of claim 2 wherein the ceramic material for the inner layers are selected from the group consisting of zirconia, titania and alumina.
 4. The protective coating of claim 1 wherein the water swellable ceramic material form a hydrate or hydroxide in the presence of an oxygen containing environment.
 5. The protective coating of claim 2 wherein the water swellable ceramic material is selected from the group consisting of alumina, zirconia or hafnia based components.
 6. The protective coating of claim 5 wherein the water swellable ceramic material is selected from the group consisting of aluminum nitride, zirconium nitride and hafnium nitride.
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7. The protective coating of claim 1 wherein the individual layers are about one to about 100 nanometers thick

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8. The protective coating of claim 1 wherein the individual layers are about one to about 50 nanometers thick.

9. The protective coating of claim 1 having at least one bilayer of zirconia and alumina.

10. The protective coating of claim 1 having at least one bilayer of zirconia and titania.

11. The coating of Claim 4 wherein the hydrate or hydroxide compound is selected from the group consisting of aluminum hydroxide, aluminum hydrate, and mixtures thereof.

12. The coating of Claim 1 having a thickness of up to about a micron.

13. The coating of Claim 5 wherein the coating has a thickness in a range from about 1 to 50 nanometers.

14. The coating of Claim 1 wherein the first module has a thickness in the range from about 1 to about 100 nm.

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15. The coating of Claim 1 wherein the second module has a thickness in the range from about 1 to about 100 nm.

16. The coating of Claim 1 wherein the third module has a thickness in the range from about 1 to about 100 nm.

17. A nanostructure protective coating for a substrate, the coating comprising a plurality of nano-scale ceramic layers comprising at least two components selected from the group consisting of zirconia, titania, alumina, and aluminum nitride.

18. A nanostructure protective coating for a substrate, the coating comprising an outermost coating layer comprising a compound capable of forming a hydrate or hydroxide compound upon contact with an oxygen containing environment and an innermost coating layer comprising a bilayer of ceramic materials.

19. The coating of Claim 18 wherein the outermost layer comprises an aluminum compound.

20. The coating of Claim 19 wherein the aluminum compound is aluminum nitride.

21. An implant, comprising:

a substrate selected from the group consisting of metals, polymers, and a combination thereof; the substrate having a protective coating thereon, the protective coating comprising:

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a plurality of modules comprising
a first module comprising a number (m) of bilayers comprising zirconia
and alumina wherein (m) is a number greater than 1;
a second module disposed on the first module comprising a number (n)
of bilayers comprising zirconia and titania wherein (n) is a number greater
than 1; and
a third module disposed on the second module comprising a third-
module compound capable of forming a hydrate or hydroxide compound upon
contact with an oxygen containing environment.

22. The implant of Claim 21 wherein the third module-compound
comprises aluminum.

23. The implant of Claim 21 wherein the third module-compound
comprises aluminum nitride.

24. The implant of Claim 21 wherein the hydrate or hydroxide
compound is selected from the group consisting of aluminum hydroxide,
aluminum hydrate, and mixtures thereof.

25. The implant of Claim 21 wherein the coating is in a range from
about 1 to about 100 nanometers.

26. The implant of Claim 21 wherein the coating is in a range from
about 1 to 50 nanometers.

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~~27. An intracorporeal implant, comprising:~~

~~a substrate selected from the group consisting of metals, polymers, and a combination thereof having a protective coating thereon, comprising:~~

~~a plurality of nano-scale ceramic layers of zirconia, titania, alumina, and aluminum nitride.~~

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28. An intracorporeal implant, comprising a substrate selected from the group consisting of metals, polymers, and a combination thereof having a protective coating thereon which has an outermost coating layer comprising a compound capable of forming a hydrate or hydroxide compound upon contact with an oxygen containing environment.

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~~29. The implant of Claim 28 wherein the outermost coating layer comprises an aluminum compound.~~

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~~30. The implant of Claim 29 wherein the aluminum compound is aluminum nitride.~~

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